# SECTION I—AEROLOGY.

## SOLAR AND SKY RADIATION MEASUREMENTS DURING FEBRUARY, 1918.

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[Dated: Washington, D. C., Mar. 30, 1918.]

For a description of instrumental exposures and an account of the methods of obtaining and reducing the measurements the reader is referred to the Review for January, 1918, 46:2.

The monthly means and departures from normal values in Table 1 show that direct solar radiation intensities averaged slightly above normal at Madison, Wis., slightly below at Lincoln, Nebr., and Santa Fe, N. Mex., and decidedly below at Washington, D. C.

Table 3 shows an excess of radiation of about 4 per cent and 3 per cent, respectively, at Washington and Madison, as compared with the normal radiation for these stations for February, and a deficiency of about 6 per cent for Lincoln.

In Table 4 are given the results obtained by extrapolating to zero air mass series of readings by the Marvin pyrheliometer that indicated steady atmospheric conditions during a half-day period.

Skylight polarization measurements obtained at Washington on 5 days during the second half of the month give a mean 47 per cent, with a maximum of 65 per cent on the 26th. These values are considerably below the average for Washington in February. No polarization measurements were obtained at Madison on account of the continuous presence of snow on the ground.

TABLE 1.—*Solar radiation intensities during February, 1918.*

[Gram-calories per minute per square centimeter of normal surface.]

**Washington, D. C.**

| Date | Sun's zenith distance. 0.0° | 48.3° | 60.0° | 66.5° | 70.7° | 73.6° | 75.7° | 77.4° | 78.7° | 79.8° |
|---|---|---|---|---|---|---|---|---|---|---|
| | Air mass. 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 |
| 1918. A. M. | cal. | cal. | cal. | cal. | cal. | cal. | cal. | cal. | cal. | cal. |
| Feb. 4 | | | 1.15 | 1.03 | 0.91 | | 0.72 | | | |
| 11 | | 1.17 | 1.01 | | | | | | | |
| 14 | | | 0.86 | | 0.61 | 0.56 | 0.52 | | | |
| 15 | | 1.32 | 1.18 | | | | | | | |
| 18 | | 1.26 | 1.01 | 0.95 | 0.88 | 0.83 | | 0.73 | | |
| 21 | | 1.28 | 1.10 | 0.95 | | | | | | |
| 23 | | 1.42 | 1.16 | 1.04 | 0.96 | | 0.82 | 0.74 | 0.66 | |
| 25 | | | | 0.79 | | | 0.63 | | | |
| 26 | | 1.49 | 1.37 | 1.28 | 1.22 | 1.16 | | | | |
| 27 | | 1.37 | | 1.24 | 1.01 | | 0.79 | 0.70 | | |
| Monthly means | | 1.33 | 1.10 | 1.04 | 0.93 | 0.85 | 0.70 | 0.72 | (0.66) | |
| Departure from 10-year normal | | −0.06 | −0.12 | −0.08 | −0.11 | −0.11 | −0.16 | −0.14 | −0.12 | |
| P. M. | | | | | | | | | | |
| Feb. 11 | | | 1.01 | 0.89 | 0.80 | 0.73 | 0.66 | 0.60 | | |
| 15 | | | 0.72 | 0.70 | 0.58 | 0.48 | | | | |
| 18 | | | | 1.12 | 1.08 | 0.96 | 0.84 | 0.73 | 0.68 | 0.64 |
| 21 | | | 1.13 | 1.03 | 0.84 | 0.73 | 0.59 | 0.54 | 0.50 | 0.47 |
| 23 | | | 1.22 | | | | | | | |
| 26 | | | 1.31 | 1.20 | 1.11 | 1.04 | 0.98 | 0.91 | 0.83 | 0.77 |
| Monthly means | | | 1.08 | 0.99 | 0.88 | 0.79 | 0.77 | 0.70 | 0.67 | 0.63 |
| Departure from 10-year normal | | | −0.14 | −0.12 | −0.13 | −0.11 | −0.08 | −0.10 | −0.08 | −0.09 |

TABLE 1.—*Solar radiation intensities during February, 1918*—Contd.

**Madison, Wis.**

| Date | Sun's zenith distance. 0.0° | 48.3° | 60.0° | 66.5° | 70.7° | 73.6° | 75.7° | 77.4° | 78.7° | 79.8° |
|---|---|---|---|---|---|---|---|---|---|---|
| | Air mass. 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 |
| 1918. A. M. | cal. | cal. | cal. | cal. | cal. | cal. | cal. | cal. | cal. | cal. |
| Feb. 15 | | | 1.52 | 1.37 | | | | | | |
| 22 | | 1.55 | 1.43 | 1.31 | 1.21 | 1.09 | 1.03 | 0.97 | | |
| 23 | | | | | 1.22 | 1.15 | 1.09 | 1.00 | 0.98 | |
| 26 | | | | | 1.30 | | 1.16 | 0.95 | | |
| Monthly means | | (1.55) | (1.48) | (1.34) | 1.24 | (1.12) | 1.09 | 0.97 | (0.98) | |
| Departure from 8-year normal | | +0.03 | +0.10 | +0.03 | ±0.00 | −0.08 | −0.06 | −0.05 | +0.06 | |
| P. M. | | | | | | | | | | |
| Feb. 6 | | | | 1.17 | 1.04 | 0.84 | | | | |
| 12 | | | | 1.24 | 1.20 | 1.11 | | | | |
| 15 | | | 1.46 | | | | | | | |
| Monthly means | | | (1.46) | (1.20) | (1.12) | (0.98) | | | | |
| Departure from 8-year normal | | | +0.06 | −0.12 | −0.10 | −0.16 | | | | |

**Lincoln, Nebr.**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| A. M. | | | | | | | | | | |
| Feb. 3 | | | 1.46 | 1.39 | | | | | | |
| 6 | | | 1.42 | 1.34 | 1.26 | 1.21 | 1.15 | 1.08 | 1.03 | 0.97 |
| 20 | | | | 1.34 | | 1.13 | | | | |
| 23 | | | 1.28 | 1.18 | 1.09 | 1.06 | | | | |
| Monthly means | | | 1.39 | 1.31 | (1.18) | 1.13 | (1.15) | (1.08) | (1.03) | (0.97) |
| Departure from 3-year normal | | | −0.04 | −0.02 | −0.07 | −0.01 | +0.07 | +0.06 | −0.01 | +0.02 |
| P. M. | | | | | | | | | | |
| Feb. 3 | | | | 1.29 | | | | | | |
| 16 | | | 1.36 | 1.30 | 1.19 | 1.12 | 1.05 | 1.00 | | |
| 22 | | | | 1.22 | | | | | | |
| 23 | | | 1.33 | | | | | | | |
| Monthly means | | | (1.34) | 1.27 | (1.19) | (1.12) | (1.05) | (1.00) | | |
| Departure from 3-year normal | | | −0.06 | −0.03 | −0.08 | −0.06 | −0.04 | −0.09 | | |

**Santa Fe, N. Mex.**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| A. M. | | | | | | | | | | |
| Feb. 1 | | 1.48 | 1.39 | 1.34 | | | | | | |
| 9 | | 1.51 | 1.41 | 1.32 | 1.24 | | | | | |
| 13 | | | | | | 1.15 | 1.10 | 1.02 | | |
| 14 | | | 1.40 | 1.33 | 1.25 | 1.20 | 1.17 | 1.13 | | |
| 15 | | | | 1.29 | | | | | | |
| 23 | | | | | 1.25 | | | | | |
| Monthly means | | (1.50) | 1.40 | 1.32 | 1.25 | (1.18) | (1.14) | (1.08) | | |
| Departure from 6-year normal | | −0.07 | −0.06 | −0.05 | −0.05 | −0.09 | −0.08 | ±0.00 | | |
| P. M. | | | | | | | | | | |
| Feb. 1 | | | 1.47 | 1.39 | 1.30 | 1.22 | | | | |
| 9 | | | 1.40 | 1.32 | 1.22 | 1.13 | 1.04 | | | |
| 12 | | | 1.32 | 1.27 | | | | | | |
| 14 | | | 1.31 | | | | | | | |
| 16 | | | | 1.30 | 1.24 | 1.17 | | | | |
| 19 | | | | 1.40 | 1.33 | 1.25 | | | | |
| Monthly means | | | 1.38 | 1.34 | 1.27 | 1.19 | (1.04) | | | |
| Departure from 2-year normal | | | −0.01 | −0.01 | −0.02 | | −0.11 | | | |

TABLE 2.—*Vapor pressures at pyrheliometric stations on days when solar radiation intensities were measured.*

| Washington, D. C. | | | Madison, Wis. | | | Lincoln, Nebr. | | | Santa Fe, N. Mex. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dates. | A. M. | P. M. | Dates. | A. M. | P. M. | Dates. | A. M. | P. M. | Dates. | A. M. | P. M. |
| 1918. | *mm.* | *mm.* | 1918. | *mm.* | *mm.* | 1918. | *mm.* | *mm.* | 1918. | *mm.* | *mm.* |
| Feb. 4 | 1.12 | 0.64 | Feb. 6 | 2.16 | 2.74 | Feb. 3 | 1.32 | 1.52 | Feb. 1 | 1.32 | 1.96 |
| 11 | 4.17 | 4.57 | 12 | 4.17 | 3.45 | 6 | 3.99 | 5.16 | 9 | 2.16 | 2.06 |
| 14 | 3.81 | 7.29 | 15 | 0.97 | 1.07 | 16 | 0.86 | 1.24 | 12 | 2.74 | 2.74 |
| 15 | 7.57 | 3.81 | 22 | 0.97 | 1.88 | 20 | 0.48 | 0.74 | 13 | 2.74 | 2.16 |
| 18 | 1.78 | 2.87 | 23 | 2.62 | 4.75 | 22 | 1.68 | 3.00 | 14 | 2.26 | 2.06 |
| 21 | 1.24 | 1.19 | 26 | 1.68 | 2.87 | 23 | 3.15 | 5.79 | 15 | 2.74 | 2.06 |
| 23 | 1.88 | 2.87 | ..... | ..... | ..... | ..... | ..... | ..... | 16 | 1.96 | 2.06 |
| 25 | 6.02 | 7.57 | ..... | ..... | ..... | ..... | ..... | ..... | 19 | 2.16 | 1.52 |
| 26 | 2.36 | 2.74 | ..... | ..... | ..... | ..... | ..... | ..... | 23 | 4.75 | 3.81 |
| 27 | 3.63 | 4.17 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |

TABLE 3.—*Daily totals and departures of solar and sky radiation during February, 1918.*

[Gram-calories per square centimeter of horizontal surface.]

| Day of month. | Daily totals. | | | Departures from normal. | | | Excess or deficiency since first of month. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Washington. | Madison. | Lincoln. | Washington. | Madison. | Lincoln. | Washington. | Madison. | Lincoln. |
| 1918. | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* |
| Feb. 1 | 122 | 317 | 358 | − 84 | 112 | 95 | −84 | 112 | 95 |
| 2 | 156 | 257 | 306 | − 52 | 49 | 40 | −136 | 161 | 135 |
| 3 | 98 | 315 | 337 | −113 | 105 | 68 | −249 | 266 | 203 |
| 4 | 320 | 338 | 306 | 107 | 125 | 34 | −142 | 391 | 237 |
| 5 | 347 | 137 | 182 | 132 | − 79 | − 93 | − 10 | 312 | 144 |
| 6 | 240 | 297 | 320 | 22 | 78 | 42 | 12 | 390 | 186 |
| 7 | 281 | 176 | 272 | 59 | − 47 | − 10 | 71 | 343 | 176 |
| 8 | 252 | 30 | 34 | 27 | −196 | −251 | 98 | 147 | −75 |
| 9 | 63 | 307 | 376 | −165 | 78 | 87 | − 67 | 225 | 12 |
| 10 | 264 | 274 | 386 | 33 | 41 | 94 | − 34 | 266 | 106 |
| 11 | 313 | 269 | 196 | 79 | 33 | −100 | 45 | 299 | 6 |
| 12 | 226 | 284 | 286 | − 12 | 45 | − 13 | 33 | 344 | −7 |
| 13 | 275 | 257 | 216 | 34 | 14 | − 87 | 67 | 358 | − 94 |
| 14 | 205 | 113 | 147 | − 39 | −133 | −159 | 28 | 225 | −253 |
| 15 | 334 | 359 | 75 | 87 | 110 | −234 | 115 | 335 | −487 |
| 16 | 87 | 271 | 403 | −164 | 18 | 91 | − 49 | 353 | −396 |
| 17 | 369 | 363 | 389 | 115 | 107 | 74 | 66 | 460 | −322 |
| 18 | 371 | 167 | 271 | 114 | − 92 | − 47 | 180 | 368 | −369 |
| 19 | 67 | 32 | 226 | −193 | −231 | − 94 | − 13 | 137 | −463 |
| 20 | 282 | 393 | 437 | 18 | 127 | 114 | 5 | 264 | −349 |
| Decade departure | | | | | | | + 39 | − 2 | −455 |
| 21 | 399 | 267 | 383 | 132 | − 2 | 57 | 137 | 262 | −292 |
| 22 | 129 | 388 | 375 | −141 | 115 | 46 | − 4 | 377 | −246 |
| 23 | 394 | 343 | 363 | 120 | 67 | 31 | 116 | 444 | −215 |
| 24 | 233 | 352 | 294 | − 44 | 73 | − 41 | 72 | 517 | −256 |
| 25 | 184 | 43 | 287 | − 96 | −239 | − 51 | − 24 | 278 | −307 |
| 26 | 448 | 321 | 330 | 164 | 35 | − 11 | 140 | 313 | −318 |
| 27 | 406 | 311 | 90 | 118 | 21 | −254 | 258 | 334 | −572 |
| 28 | 333 | 164 | 368 | 41 | −129 | 21 | 299 | 205 | −551 |
| Decade departure | | | | | | | +294 | − 59 | −202 |
| Excess or deficiency since first of year: cal. | | | | | | | +137 | +869 | −755 |
| Excess or deficiency since first of year: Per cent | | | | | | | +1.1 | +7.1 | −5.0 |

TABLE 4.—*Solar radiation intensities for zenithal sun and approximate values of the solar constant.*

| Station. | Date. | Radiation intensity. | | Solar constant. |
|---|---|---|---|---|
| | | m=1 | m=0 | |
| | 1918. | *cal.* | *cal.* | *cal.* |
| Lincoln, Nebr. | Feb. 3 | 1.54 | 1.71 | ..... |
| Lincoln, Nebr. | Feb. 16 | 1.52 | 1.73 | ..... |
| Santa Fe, N. Mex. | Feb. 1 | 1.62 | 1.84 | 1.92 |
| Santa Fe, N. Mex. | Feb. 9 | 1.56 | 1.78 | 1.87 |

## NOCTURNAL RADIATION MEASUREMENTS.

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[Dated: Washington, Feb. 19, 1918.]

### APPARATUS.

In making the nocturnal radiation measurements here summarized a modification of the Ångström electrical compensation instrument has been employed.[1] As is well known, the radiating surface in this instrument consists of two thin blackened strips of manganin. The rate at which these strips lose heat by radiation is determined by measuring the electric current that must be passed through them in order to maintain temperature equilibrium between them and two other strips of manganin similar to these in every way except that their surfaces are bright. The bright strips are exposed beside the blackened strips, and under exactly the same conditions.

*The pyrgeometer.*—Figure 1 shows the bright strips ($W$, $W$) and black strips ($B$, $B$) mounted on a hard rubber frame in the end of a nickel-plated tube. In order to determine when the four strips are in temperature equilibrium thermo-electric junctions ($j$, $j$) are provided at their backs, but electrically insulated from them. These junctions are connected in series in a circuit that also includes the coil of a delicate galvanometer, $G$. A slight temperature difference between the junctions back of the bright and the black strips, respectively, generates a current which, passing through the galvanometer coils, deflects them from their zero position. The blackened strips are then warmed by passing through them an electric current, which is adjusted to such strength that the galvanometer coils return to their zero position, indicating the establishment of the temperature equilibrium sought. Under these conditions the blackened strips are receiving the same amount of heat that is being lost by radiation, provided the bright strips are perfect reflectors and do not lose heat by radiation. Actually, however, the bright strips are imperfect reflectors and lose some heat by radiation. The electric heating current is therefore a measure of the difference in the radiating powers of the bright and the black strips. Such devices have been called pyrgeometers by A. Ångström (op. cit., p. 28).

The Weather Bureau has had four of these pyrgeometers constructed. Nos. 1, 2, and 3, had two blackened and two bright manganin strips, the bright strips being gold plated. Five silver-bismuth thermo-electric junctions are provided at the back of each strip, so that there are 10 warm and 10 cold junctions on each instrument. These junctions were made by Dr. W. W. Coblentz,[2] of the United States Bureau of Standards, who also prepared the bright and black strips and mounted them on sup-

[1] *Ångström, Knut.* Über die Anwendung der elektrischen Kompensationsmethode zur Bestimmung der nächtlichen Ausstrahlung. Nova acta, Regiæ societatis scientiarum Upsaliensis, Upsala, 1905, Ser. IV, vol. 1. N. 2.

[2] *Coblentz, W. W.* Instruments and methods used in radiometry. Bull., U. S. Bureau of Standards, 1913, **9**: 7–63.